WASHINGTON
# SCIENCE TRENDS

HIGHLIGHTS

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## * FLAKE-GLASS LAMINATES

Achieving the theoretical possibilities of flake-glass laminates as a substitute for glass fiber is apparently a more difficult task than originally expected, according to a state-of-the-art review by the Army's Plastics Technical Evaluation Center (Plastec). The review indicates that the art of constructing such laminates is in its "first rudimentary state", with only a small number of experimental specimens exhaustively tested.

Background -- Interest in flake-glass laminates appears to have been an outgrowth of shortages of mica during World War II. Dr. Vannevar Bush, upon seeing glass films being blown, is said to have suggested their use as a resin-reinforcing material instead of glass fibers or mica. Intensive research studies began in 1953.

Theoretical Advantages -- Work to date has not shown that it will be impossible to achieve any of these five major theoretical advantages:

- ✓ Superior strength to weight ratio than glass fiber laminates due to multi-directional stress bearing capability.
- ✓ Flakes are thinner than the glass fiber or woven fabric and can be packed more closely together. Therefore, any given thickness of plastic would contain less of the bonding agent and a higher percentage of glass reinforcement.
- ✓ Modulus of elasticity of flake-reinforced plastics would be greater than conventionally reinforced plastics because flakes would have fewer degrees of freedom than fibers.
- ✓ It is expected that flake-reinforced plastics would be the cheapest to produce because flakes are cheaper than glass fiber or cloth.
- ✓ The vast number of flakes arranged in a continuous layer or layers would result in a material that was virtually impervious to water and water vapor.

Applications -- Among military applications suggested by defense contractors are aircraft and missile radomes; coatings and moisture-vapor barriers; electrical potting mixes; battery cases, instrument cases and similar items; rocket exhaust nozzles; rocket-motor cases and rocket fins.

Problems -- The Army study indicates that many samples prepared by large-scale production techniques will have to be tested before any conclusive statements can be made. In general, the few samples thus constructed have not shown the strength of samples prepared in small laboratory lots. Much research work is said to be necessary before flake glass laminates even begin to approach their calculated ultimate values, and before they can be used in operational structures.

(A complete technical review is now available through military channels or at $2.75 from OTS, U. S. Department of Commerce, Washington 25, D. C. Ask for Plastec Report No. 1.)

* RESEARCH AND DEVELOPMENT OPPORTUNITIES

Here is a new listing of U. S. Government research and development opportunities for organizations with demonstrated capabilities and facilities in specialized fields. In general, complete background information on experience, personnel, facilities, etc., should be furnished when contacting the Agencies involved.

✓ High Resolution, Brushless, Analog to Digital Converter -- Specifications for developmental models are detailed. (Interested firms have until February 15, 1961 to submit information to Chief, Bureau of Naval Weapons, U. S. Navy, Washington 25, D. C., ATTN: Code RREN-4.)

✓ High Speed Analog-to-Digital System -- Proposal information should be available at all U. S. Army Ordnance District Offices. (Bidders conference to be held at Redstone Arsenal, Bldg. 7120, Alabama, on February 27, 1961. Contact District offices or ARGMA, Special Contracts Branch, Redstone Arsenal, Alabama, ATTN: ORDXR-IXD by February 17, 1961.)

✓ Ultrasonic Transducer Program -- This program is designed to investigate mechanics and techniques of ultrasonic joining necessary to obtain reliable joints in high temperature metals up to and including one-tenth of an inch thick and to develop reliable ultrasonic transducers plus components. (Bid sets available February 13, 1961 at Aeronautical Systems Center, Wright Patterson Air Force Base, Ohio, ATTN: LMPMGC or phone CLearwater 3-7111, Ext. 3-1396.)

✓ Single Sideband Equipment -- This modular equipment should be of advanced original design, including but not limited to, solid state techniques and operating as a shipboard communication receiver in the 2 to 32 MC frequency range. (Firms with a confidential industrial facility clearance can obtain details in RFP 687-18912 Q available from U. S. Navy Department, Bureau of Ships, Washington 25, D. C.)

✓ Radioactive Gas Leak Testing Unit -- This requirement includes instrumentation for leak testing cartridges and cartridge actuated devices, as well as training of operators to insure AEC certification. (Details available in IFB-178-31-61-B from Contracting Officer, U. S. Naval Weapons Laboratory, Dahlgren, Virginia.)

✓ Magnetic to Paper Tape Converter -- The Air Force would like to see technical proposals, minus any pricing information, by February 20, 1961. (Write Air Force Command and Control Development Division, ATTN: CCKPS, L. G. Hanscom Field, Massachusetts.)

* TANTALUM PROSPECTS

The Defense Metals Information Center sees a "promising future" in tantalum alloys for structural applications requiring high strengths at temperatures in excess of 1400° C.

"Tantalum," the Government-sponsored Center reports, "provides a unique combination not found in many metallic materials of low-temperature ductility and high melting point." However, alloys are required. The Center explains:

"Although strength is maintained reasonably well with increasing temperature, strength values are too low to consider tantalum for structural applications, particularly when lower density materials with higher strengths are available. Thus, for tantalum to realize its real potential, alloys must be developed to attain high strengths at temperatures in excess of about 1400° C; below this temperature low-density alloys of columbium and molybdenum are superior.

"Based on its high melting point, future tantalum alloys will be in direct competition with tungsten and its alloys. Although free-world resources of tungsten outnumber tantalum 3 to 1, the low-temperature ductility and ease of fabricability appear to favor tantalum alloys."

(Report available through military channels or at $5 from OTS, U. S. Department of Commerce, Washington 25, D. C. Ask for DMIC Report 133.)

* SPECIAL SUMMARY REPORT -- GROUND EFFECT MACHINES

Here is a further listing of U.S. Military research programs in the area of Ground Effect Machines (GEMS) continued from Washington SCIENCE TRENDS, February 6, 1961:

* BUREAU OF NAVAL WEAPONS

□ Loads and Motions of GEMS in Ditching - Convair, San Diego -- Convair will conduct an analog computer study to determine the loads and motions of Ground Effect Machines during landings in the open ocean. The loads will be compared to the normal static and landing loads and the weight penalties required to design for these impact loads will be determined. The effect of varying cushion pressure, horizontal and vertical sinking speeds and weight distribution shall be determined. Also various load alleviating devices shall be determined and the loads and motions redetermined to indicate the degree of alleviation. A report on the results of this program will be written.

□ GEM Analytic and Model Testing in Support of Basic Research - David Taylor Model Basin -- An extensive program of theoretical, experimental, and design study investigations of the ground effect phenomenon is being conducted for BuWeps. The David Taylor Model Basin Aerodynamics Laboratory has developed theoretical methods and techniques for expressing the hovering performance of thin annular jet vehicles, for determining the estimating power required to sustain GEM's of arbitrary size, shape and weight. This theoretical work has been supplemented by a series of static and wind tunnel test of circular models up to 3' in diameter to explore lift, drag, pitching moment, and rolling moment characteristics for various jet angles, jet thicknesses, angles of attack, and pressure ratios. To obtain large scale data, a man-carrying oval-shaped 4' x 7' GEM was built and tested over a circular outdoor track to determine the model's performance, stability, and control characteristics over both smooth and wave surfaces. Variable turning vanes were employed to deflect portions of the annular jet for propulsive purposes. Currently, a 15' x 6' dynamic test vehicle has been designed and built for testing in and over smooth and rough water in the new DTMB Maneuvering Basin facilities.

□ Operations Analysis of a GEM in the A.S.W. Field - Saunders Roe, Ltd. -- Saunders Roe will conduct an operational analysis study of Ground Effect Machines (GEM) in the Anti-Submarine Warfare field. The GEM will be compared with a helicopter, a hydrofoil boat, a seaplane, a land-based patrol airplane, and a carrier-based airplane. A comparison of the aerodynamic performance, structural weight, and operational capabilities of the machines will be determined for the various ASW missions.

* NAVY BUREAU OF SHIPS

□ Design, Construction and Evaluation of 18 Ft. Test Craft - Bell Aerosystems Company -- The Principal characteristics of this test craft are: Length, 18'; Beam, 8'; Weight 3000 lbs.; Speed, 30 knots; Air Power, 75 hp. Porsche; Propulsive Power, 80 hp. Mercury. Evaluation testing on this craft will cover the areas of Handling Characteristics: three types of skegs (knife edge, ship shape and planning); range of nozzle angles and thicknesses; range of speeds and maximum; full, partial and no air flow; turning radius with full rudder; acceleration runs. Internal air flow and base pressure and thrust and drag versus speed measurements.

* NAVY BUREAU OF SHIPS (Continued)

- Ground Experimental Criteria - Convair, San Diego -- Two models will be constructed in which various load determining tests will be conducted. One model will represent Chaplin's integrated GEM and the second vehicle will be a wall-sided type with considerable flexibility provided to alter the skeg arrangement. Tests similar to those conducted for seaplanes will be utilized. Structural loads will be obtained due to ditching, striking wave tops, and due to normal operation over a wave system.

- GEM Performance and Design Analysis and Stability and Control Investigation - David Taylor Model Basin -- Stability and control tests have been conducted in the DTMB Aero Laboratory on the integrated GEM model (15' x 6'). The model was towed in a constrained manner and force and moments in the 6 degrees of freedom were measured. Analogue computer studies follow. A series of small (2' x 3') model tests aimed at developing a more refined external shape have been conducted. Also, various power saving devices have been studied with the idea of incorporating new information into future DTMB models. Further tests have been conducted on the 12' wall-sided model. These tests included resistance in both calm water and wave conditions as well as stability and control work. This effort is also directed toward the development of a future model of a more refined design.

- GEM Water-Wall Parametric Studies - Hughes Tool Company -- A major part of this effort has been directed toward a parametric investigation of the sealing effect of the water-wall concept. A range of height to 4', discharge velocities of 20 to 100 feet per second, a wide range of certain thicknesses and discharge angles were studied. Base pressures up to 50 lbs. per square foot were included. A second part of the study included an investigation of the method of air leakage. Here smoke, tufts, and high speed photography were used. In addition, a limited analytical stability and control study has been undertaken. Special emphasis was placed on the damping characteristics of various types of Ground Effect Machines.

- Procurement of Two GEM (Experimental) - Hughes Tool Company -- This contract covered purchase of 2 GEM experimental vehicles. One vehicle is a 21' x 11' wall-sided craft with a water curtain at the bow and stern. Power is furnished by an 80 hp. Mercury outboard engine. Performance characteristics are: clearance of 2' and forward speed in excess of 30 knots. The second vehicle is a 14' x 9' eight-sided craft which has a full water wall. Internal jets compartment the base into 4 sections. This craft has a water clearance of approximately 8" and complements the stability and control work sponsored under separate contract. Extensive test programs have been accomplished for both of the above vehicles.

- Study of Jet Penetration of Water - Northwestern University -- The basic objective of this task is to obtain quantitative information regarding the shape and stability of a cavity or depression formed by a high velocity air jet penetrating the surface of the water. Additional objectives include the investigation of the spray generation mechanism and the noise transmission characteristics associated with the phenomenon.

* U. S. MARINE CORPS

- GEM NR. 1 for the U. S. Marine Corps - National Research Associates -- The contractor has constructed a full-scale vehicle operating on the Ground Effect phenomena. Vehicle is 8' x 14' and employs the peripheral jet principle to achieve a Ground Cushion Effect. Total weight is approximately 1,200 lbs.; powered by 2 Triumph motorcycle engines of 40 hp. each. A system of 4 (2 forward and 2 aft) six bladed fans are employed as air generators. Controls are provided by deflector vanes mounted within the peripheral jet slipstream.

- GEM NR. 2 for the U. S. Marine Corps -- Fabrication of this vehicle was essentially complete at the time of contract amendment (Contract Nonr-2747(00) with Aerophysics Co.) for procurement of the completed machine from Mr. Carl Weiland. The vehicle is of aluminum and plywood construction, 30' x 33' overall dimensions, powered by 2 Ford Industrial engines rated at 270 hp. each, plus 2 Lycoming Aircraft engines (O-320) rated at 150 hp. each. Incorporated are 300 separate watertight compartments, 8" in depth, to provide for flotation. Four fans of approximately 4-ft. diameter are provided in the nose of the vehicle for high forward speed and to provide air flow through an annular jet system for the air cushion. Control and stability are provided by vanes and differential nose fan action. At forward speed, a pair of conventional type rudders aft are provided for directional control. Reverse thrust vanes are provided for deceleration.

- GEM NR. 3 for the U. S. Marine Corps - National Research Associates -- Following the acceptance and environmental testing of the first NRA Ground Effect Machine, a second machine designated as GEM No. 3 was contracted for with the same firm. The contract specifies that the contractor will design and construct a second Ground Effect Vehicle, patterned basically from the initial efforts, but with the following exceptions: Increase size to 22' x 12' overall dimensions, alter configurations; employ 2 Solar T-62 gas turbines of 80 hp. each.

* U. S. ARMY TRANSPORTATION CORPS

- Air-Cushion Feasibility Investigation - Aeronutronic Division -- A "state-of-the-art" study has gathered information from all government agencies and industrial concerns funded by the government in this field. Laboratory experiments were conducted to develop needed data for correlation; an analysis covered the feasibility of this transport concept. Objective of the above work was delineation of detail engineering aspects of air-cushion vehicles; such data formed background for estimating power requirements. Major concern was with what it takes to make the vehicles operate. Application analysis, configuration studies and system evaluation studies make up the remainder of this task.

- Investigation of Basic Ground Effects Phenomena - Princeton University -- Princeton is presently concentrating on GEM stability problems at higher hover heights, utilizing the 20-Ft. circular test model repowered with a 180 hp. engine for that purpose.

(Research Programs summarized by Lt. Col. J. L. Wosser and Lt. Cdr. A. J. Van Tuyl, Air Programs, Office of Naval Research, Washington 25, D. C., and reported to Society of Automotive Engineers)

# RESEARCH CHECKLIST

□ NEW VACUUM EVAPORATION APPARATUS: Simple and accurate production of the replicate specimens used in electron microscope studies is said to be possible with a new device developed by the National Bureau of Standards. The unit is a small vacuum chamber in which a series of vacuum evaporations may be accomplished in rapid succession. The chamber has several access ports to which attachments may be fitted for making different types of specimens.

(Details available. Single Copies Free. Write National Bureau of Standards, Office of Technical Information, Washington 25, D.C. for Summary Technical Report -- Apparatus for Vacuum Evaporations)

□ NEW DATA ON HIGH TEMPERATURE MATERIALS: First determination of accurate entropies and high temperature heat contents for many of the oxides of tungsten and molybdenum have been reported by the Bureau of Mines. The new data will make it possible to conduct more sophisticated and accurate thermodynamic calculations of these materials which are being considered for wide application in very high temperature vehicles and equipment.

(The new data is contained in the report entitled, "Thermodynamics of Some Oxides of Molybdenum and Tungsten", available through the Bureau of Mines, Publications-Distribution Office, 4800 Forbes Avenue, Pittsburgh, Penna.)

□ PORTABLE DROP TESTER: The Navy has developed a portable drop tester designed to simulate water entry, countermine, explosive separation, and shipboard shocks on weapon components and systems. The unit may eventually replace expensive permanently-installed drop towers for many types of impact tests. Called a "self-emplacable drop tester," the device requires only a crane to subject 100 pound loads to shocks of 250 to 10,000 gravities. All parts are contained in one unit of 1,050 pounds. The device is believed to be inexpensive enough for expendable use in high-g shock tests involving radioactive elements and rugged enough to be used repeatedly for tests or ordnance components in the field. Performance of an experimental version is said to be satisfactory for impacts 2 milliseconds or greater in duration and up to 3,000 g in amplitude.

(R&D by Environment Simulation Division, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Maryland)

□ ANALOGUE SIMULATOR: The Army is sponsoring development of an analogue simulator which is designed to aid in flood control programs in the Kansas River basin. The river system includes some 1,000 miles of channel and ten reservoirs which are used during periods of heavy rainfall to alleviate, temporarily, potential flood conditions. Object of the development is to use the complicated system of reservoirs in the best possible fashion, maintaining the channels bank-full without any actual overflow, if possible. In operation, the simulator will digest data from 70 rain gauges, rainfall prediction data, and data on thunderstorm activity -- converting this information in streamflow figures. Various methods of utilizing the reservoirs to relieve danger points can then be simulated.

(Development by H. A. Einstein and J. A. Harder, University of California, Berkeley, California under contract with U. S. Army Corps of Engineers, Kansas City District)

□ PYROPHORIC REACTION OF TITANIUM AND LIQUID OXYGEN: Studies by the Battelle Memorial Institute for the Air Force have shown that five factors contribute to the starting of a fire in a liquid oxygen tank made of titanium when the tank is struck by a solid object. These factors are: exposure of a fresh surface by fracture and tearing, deformation by impact, impact of smooth clean flat surfaces, LOX pressure and velocity, and galling. No one of these factors could be isolated as the primary cause of fire under any type of impact. Titanium, which has good oxidation resistance, has been shown through operational experience during the last few years to be more susceptible than most metals to violent reactions with liquid oxygen.

(Details of the Battelle study are contained in WADD Technical Report 60-258 available through military channels or for $1.50 from OTS, U.S. Dept. of Commerce, Washington 25, D.C.)

□ ELECTRICAL THROTTLE SYSTEM: A new electrical throttle control system will be used with the J-93 jet engines which will power the B-70 Valkyrie bomber. The system is based upon a lightweight motor which can operate in conditions ranging from +550° to -65° F. Frame is of stainless steel and wiring is encapsulated in ceramic. The device is said to be advantageous because it is not subject to the problems of structural deflections and varying temperatures encountered in various portions of the airframe during flight.

(Design and development by Electrical Systems Equipment Group, North American Aviation, Los Angeles 45, California)

□ WAVEGUIDE JUNCTION RESEARCH: Many "new and useful applications" are envisioned by Navy researchers in a six-port trimode turnstile waveguide junction now under development. The junction is said to possess a unique combination of matching, isolating and power-splitting properties. One application is the instantaneous measurement of polarization.

(R&D reported by R. S. Potter and C. E. Jedrey, Jr., Tracking Branch, Radar Division, U.S. Naval Research Laboratory, Washington 25, D.C.)

□ SATELLITE TRAJECTORY SIMULATOR: A new type of slide rule developed for the Air Force is said to pinpoint the path of a satellite and determine geographical areas visible from the orbiting vehicle. The so-called Satellite Trajectory Simulator can also provide the frequency and times the satellite will pass over any predetermined point, or may be worked "backwards" to determine the launch conditions such as time and place. The simulator consists of a square metallic base and two replaceable concentric, transparent plastic disks fixed to the base at the center, with free independent rotation about the center.

(Developed for Intelligence Laboratory, Rome Air Development Center, Griffis Air Force Base, N.Y. by Planning Research Corp., Los Angeles, California)

□ DETERMINING COPOLYMER COMPOSITION: A precise procedure for determining copolymer composition has been developed by the Government in connection with the national synthetic rubber program. The method is based on the amounts of water and carbon dioxide formed when a copolymer sample is burned. Researchers have been using this technique to analyze butadiene-styrene copolymers on a rapid, routine basis. Other copolymers containing monomers differing significantly in carbon-hydrogen ratio could be analyzed with little modification of the present procedure.

(Details available. Write National Bureau of Standards, Office of Technical Information, Washington 25, D.C. for information on "Determination of Copolymer Composition")

# PUBLICATION CHECKLIST

- V/STOL AIRCRAFT, a fine study by the staff of the Langley (Va.) Research Center of the NASA. Emphasized are predictions regarding the various types of vertical and short take-off and landing (V/STOL) aircraft likely to be developed for commercial transport applications, estimates of performance and possible operating procedures, and the approximate dates these aircraft should be available for use. Includes a bibliography of all unclassified V/STOL research papers published by NASA to date. 131 Pages. (Available free from NASA, 1520 H Street, N.W., Washington 25, D.C., ATTN: BID or at $2.75 from OTS, U.S. Department of Commerce, Washington 25, D.C. Ask for NASA Technical Note D-624)

- INDUSTRIAL RESEARCH LABORATORIES OF THE U.S., a new edition of a standard reference work presenting detailed information on the activities of 5,420 laboratories in 4,145 industrial firms and other organizations. Provides a personal-name index of approximately 20,000 individuals engaged in research. 700 Pages. $12. (Write Publications Office, National Academy of Sciences, Washington 25, D.C. for Publication No. 844)

- TERRAIN FLYING, a pocket-sized guide of airman's lore for the average pilot. Typical Advice: "Pennsylvania Turnpike tunnels frequently do not come out where you expect them, and the ground above them is always high." 40 cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D.C. for "Terrain Flying")

- FIELD ELECTRON AND ION EMISSION, a bibliography including brief abstracts of published Soviet efforts in these fields from 1955 to 1959. Includes work on field electron emission from metals and semiconductors, work functions, phase transformation, absorption, diffusion, etc. 37 Pages. $1.25 (Write OTS, U.S. Department of Commerce, Washington 25, D.C. for NBS Technical Note No. 75)

- LONG RANGE SPACE PLANNING, an unusual report by H. H. Koelle of the Marshall Space Flight Center, Huntsville, Alabama which asserts that it is possible to estimate launch operations costs of present and future space vehicles as a function of firing rate, and that present ranges will be able to handle all forseeable launchings. 36 Pages. Single Copies Free. (Write NASA, 1520 H Street, N.W., Washington 25, D.C., ATTN: BID, for NASA Technical Note D-597)

- BOATS OF THE U.S. NAVY, a catalog of Navy boats which are "uncommissioned waterborne units of the Fleet, not designated as service craft, and capable of limited independent operation." 104 Pages. $1.75. (Write Superintendent of Documents, Government Printing Office, Washington 25, D.C. for Publication D 211.2:B 63/960)

- GOVERNMENT RESEARCH REPORTS: The following selective bibliographies listing Government research reports, translations and other technical documents available to science and industry may now be obtained (at 10 cents each) from OTS, U.S. Department of Commerce, Washington 25, D.C.:

  SB 421 -- Alkali Metals (Lithium, sodium, potassium, rubidium, cesium)
  SB 422 -- Alkaline Earth Elements (barium, calcium and strontium)
  SB 423 -- Powder Metallurgy
  SB 424 -- Liquid Metals
  SB 425 -- Molten and Fused Salts
  SB 426 -- Magnetohydrodynamics
  SB 427 -- Magnetostriction
  SB 428 -- Transducers
  SB 432 -- Thermoelectricity
  SB 435 -- Semiconductors